Biomimetic Multi Height Structures in Injection Molded Polymer

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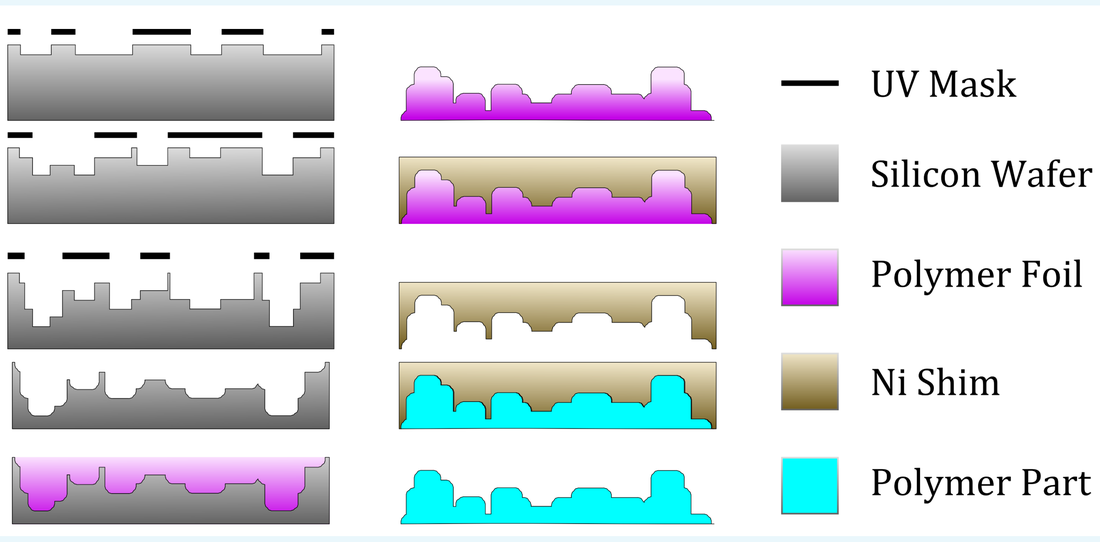
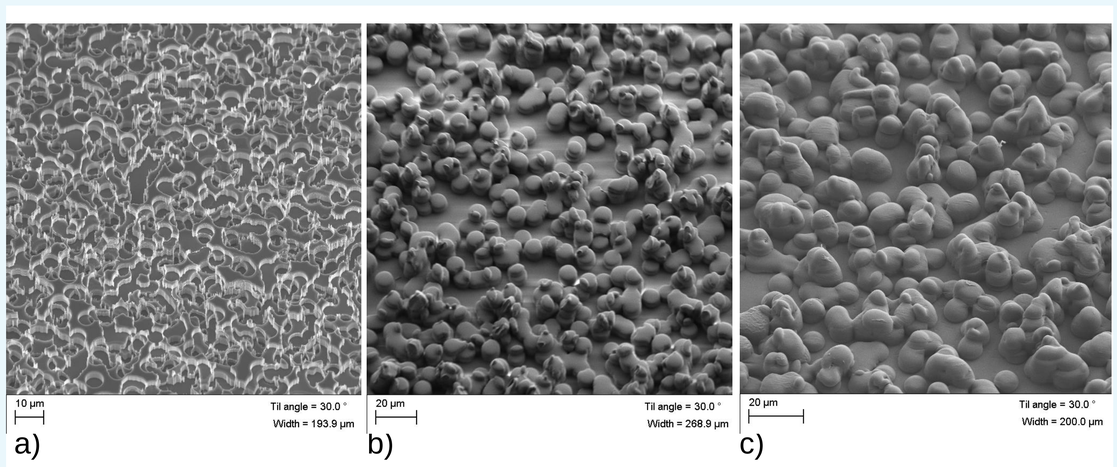
Since the discovery of the special surface structures giving rise to super hydrophobic surfaces in nature researchers have sought to artificially replicate the effect by micro and nano structuring surfaces. This often done by applying a wide range of cleanroom processes developed by the microelectronics industry, often leading to surface structures of similar heights. In this study, the fabrication process is designed to achieving multiple heights to better replicate surfaces seen in nature.

Sample Fabrications via Injection Molding with cleanroom fabricated mold insert

Multiple exposures and etching steps with a random mask results in holes of multiple depths, the shape of the holes is then smoothened by thermal oxide growth. Polarity of the structures is then reversed by making an imprint in thin polymer foil. A nickel shim is then created by electroplating the polymer foil.



The mask consists of 16 different surface structures of varying surface coverage (22% 26% 30% 33%) and diameter (5µm, 7µm ,9µm and 11 µm).

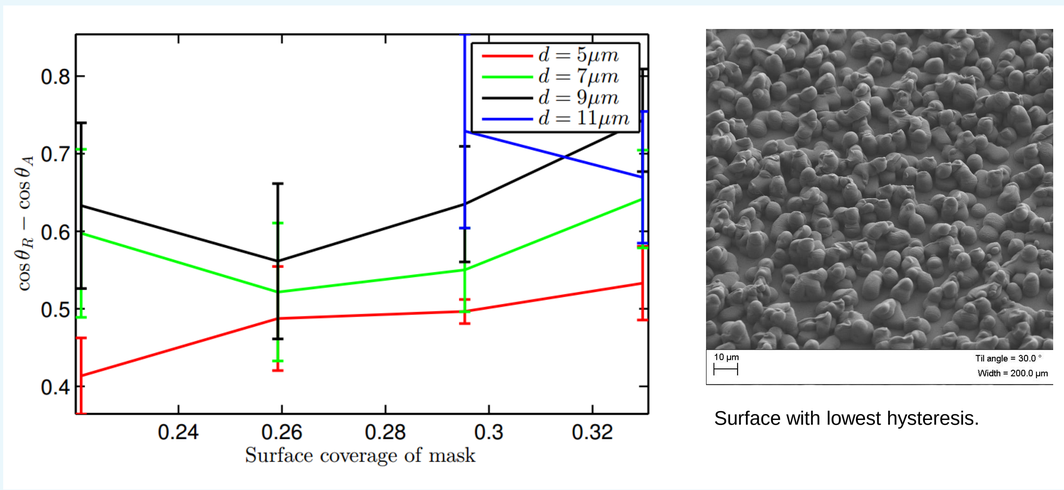


a) b) c)

SEM Images of fabricated surface structures. a) Silicon wafer after third exposure and etch. b) Polymer foil after imprint of smoothened structures. c) Injection molded sample.

Characterization

The injection molded samples have been characterized by measuring contact angle hysteresis during tilting of the sample. Due to the random nature of the samples the drop often rolls off the surface in several steps before complete roll-off, in this case the hysteresis is measured just before complete roll-off.



Surface with lowest hysteresis.

Benchmark

To compare the performance of the multi height surface structure a simple surface structure is used as benchmark. The simple surface structure consists of circular pillars of equal height in a square grid. The fabrication of the benchmark surface is similar to that of the multi height structure.